CHAPTER 4

SYSTEM DESIGN AND METHODOLOGY

Data base of this system

The Solar Energy Park of Thailand project is important for the study of solar energy because it will include many types of solar systems that apply solar energy to use in daily life. For the student, researcher and anyone who as an interest in solar energy and its application living in the Mekong region, it will be an important study source in the future. With regards to PV, water pumping installed in this park, the main installation is near the edge of the Park's big pond and placed about 40 meters to the north from the bridge that connects the land and the island for camping. The pump serves to provide water for human consumption and to support the vegetation in the approximately 14,000 m^2 area of the park.. The water that is pumped from the big pond is sent to storage in a high tank after passing through filter to clear the water of sediment The water that comes out from high tank will uses for the grounds vegetation in the North section of the energy park to water the grass and landscape plants. It will also be used for human consumption in the Training and Service building, the solar energy home system demonstration area and the energy demonstration village that has 9 houses.

Data details [Energy Park Project]

Pond physical

- There are no water plants in the pond.
- Area of pond 49,000 m^2
- Maximum of depth 7 m.
- Average level of water 5.5 m
- Volume of water in the pond 269,500 m^3

Water consumption

- Water consumption 0.3 m^3 / house / day
- The requirement water supply for 11-houses 3.3 m^3/day
- For training and Service building 5 m^3/day
- For 1 m2 of grass 0.0007 m^3/day
- Area of grass 12,600 m^2
- For grass area will use 9 m^3/day
- For the Plant building 5 m^3/day
- Etc. 10 m^3/day
- Net water volume (approx) 30 m^3/day

Research site

- Area : Solar Energy Park of Thailand, Solar Energy Research and Training Center (SERT), Naresuan University, Phitsanulok, Thailand.
- Latitude : 16 ° 44 ' North
- Longitude : 100 ° 11 ' East

Technical detail of pond

- The depth from water surface to the edge of pond 2 m
- The depth from water surface to the bottom of pond 5 m
- The length from tank to pump in the horizontal line 15 m
- The height from the ground to the top of tank 12 m

System design

The design of a PVP-system is generally intended to provide the best matching conditions between the energy supplied to the system by the sun and the energy required at the load. The best matching can be considered in terms of minimizing losses, maximizing efficiency, maximizing reliability, or a compromise between these goals.

4.2.1 Design procedure

- Step 1: Determining the irradiation value for the location of the system.
- Step 2: Selection of a suitable pump in accordance with the total pumping head, daily water discharge and well diameter.
- Step 3: Selection of system from the survey capacity diagram (Fig 18) based on the water requirement (m^3 / day) and total head (m) found under step2.
- Step 4: Selection of the optimum tilt angle.
- Step 5: System Performance.
  From the system performance curve for the pump type found under step 3, the head from step 2 and the irradiation values now can be used to find the average daily quantity for water month that the system is capable of pumping for a given array. See an example of performance curves in Fig 19
- Step 6: The selection of the inverter depends on the output power of the motor-pump set and their characteristics.
- Step 7: Connection of solar modules with regard to the electrical interface requirements of the inverter.

4.2.2 System sizing

The sizing and selection of a system can be made in a simpler way by using the average annual value of the irradiation. However, this method can only be recommended in cases where the variation throughout the year is not very large and where there are no special critical periods for the water requirement.

To estimate the size of a solar generator for an application such as pumping water the average daily water consumption and the head of the pond have to be known.

Instrumentation

The system consists of PV modules, motor and pump, inverter and storage tank. For the system experiment, there is a data recorder and support software PC208W. The details of each component is as follows:

- PV module:
  Model SM55 (Solartron, Co.,Ltd.)
  Power specification

Rated Power	55 Watt peak
Configuration	12 Volt
Rated Current	3.15 Amp
Rated Voltage	17.4 Volt
Short Circuit Current	3.45 Amp
Open Circuit Voltage	21.7 Volt

- Motor and pump:
  Company Grundfos International a/s Co.,Ltd
  Type Centrifugal pump type SP 5A-7
  Electrical Data:
  Nominal Data at 50 Hz

Voltage	195 Volt
Power	550 Watt, 0.75 HP
Current	8.8 Amp
Maximum Rating	1,200 Watt

- Inverter:
  - Company: Grundfos International a/s Co.,Ltd
  - Type: SA 1500
  - Electrical Data:

Input (DC)	Nominal	Maximum	Minimum
Load voltage	120 V	140 V	100 V
No-load voltage	155 V	175 V	115 V
Load current	12.5 A	14.0 A	-
Power	1,500 W	1,960 W	-
Output(AC)	Nominal	Maximum	Minimum
Current	-	14.0 A	-
Frequency	-	63 Hz	7 Hz
Efficiency	0.96	0.97	0.95

Climatic Conditions:

Ambient Temperature	-10 °C to +60 °C
Storage Temperature	-25 °C to +85 °C
Relative Humidity	Maximum 100 %

- Water storage
  - Rated capacity: 10 m^3

Collection of data

4.4.1 PV module SM55 is used with 8 modules in series and three series connected groups connected in parallel. PV modules are oriented to the south and made angle with the horizontal of 17°. The data logger is connected between the panels and the inverter to record data.. (Fig 20)

4.4.2 The data collected are include current, voltage, cell temperature, and solar radiation once every 10 minutes. The experiment ran from at 9.00 AM to 17.00 PM. for 7 days. Data outputs are from the PC208W software that was used with this system.

4.4.3 Correlation between radiation and current, voltage, flow rates and power from PV.

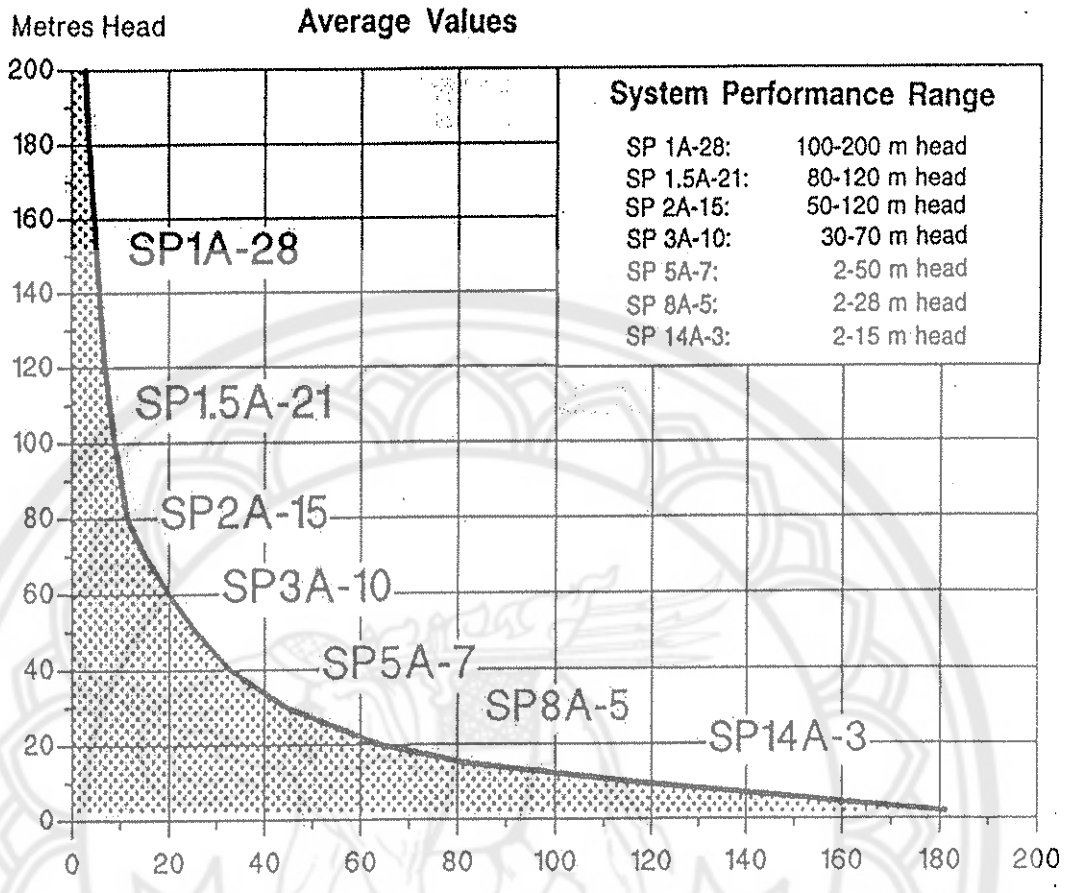

Figure 18 Grundfos motor-pump selection diagram.

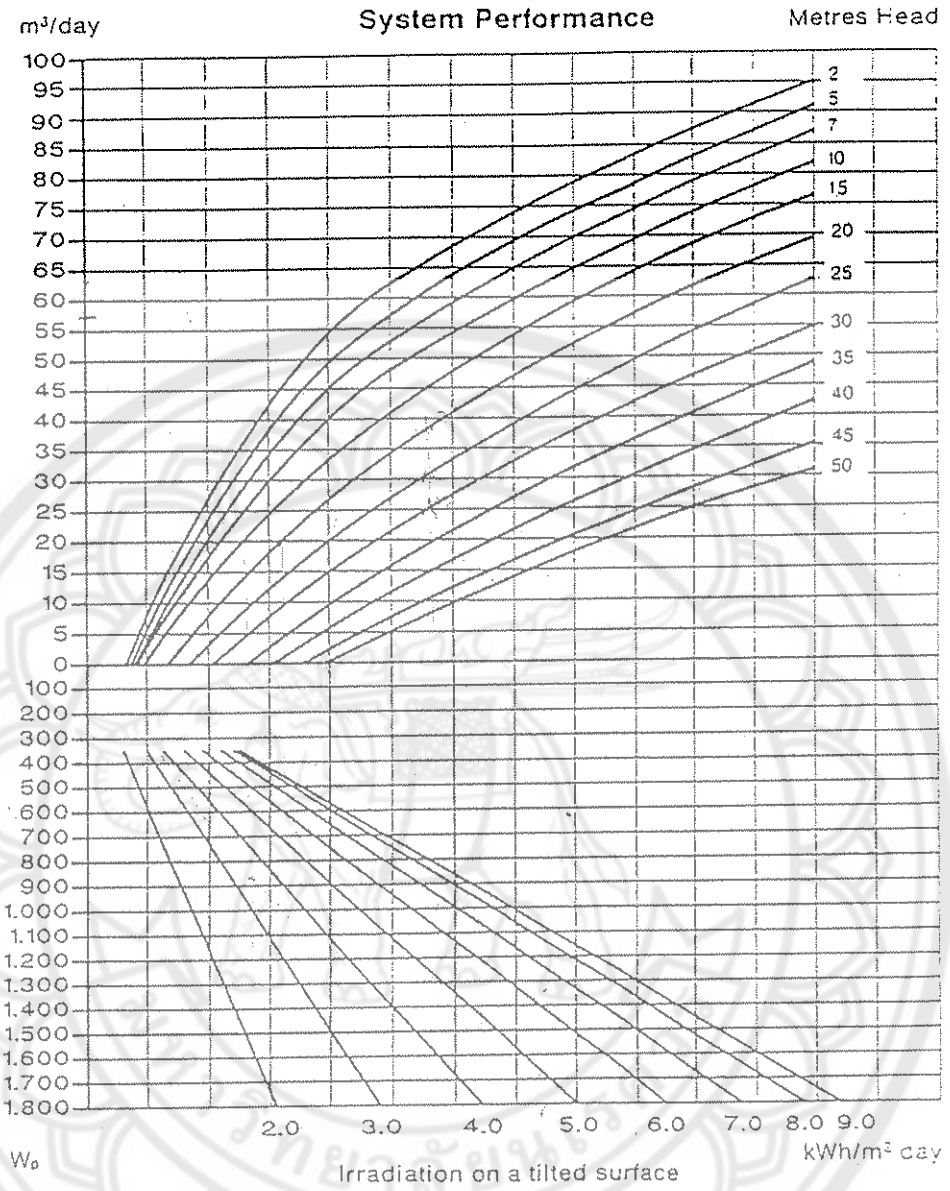

Figure 19 Grundfos SP 5A-7 as used in the measurements.

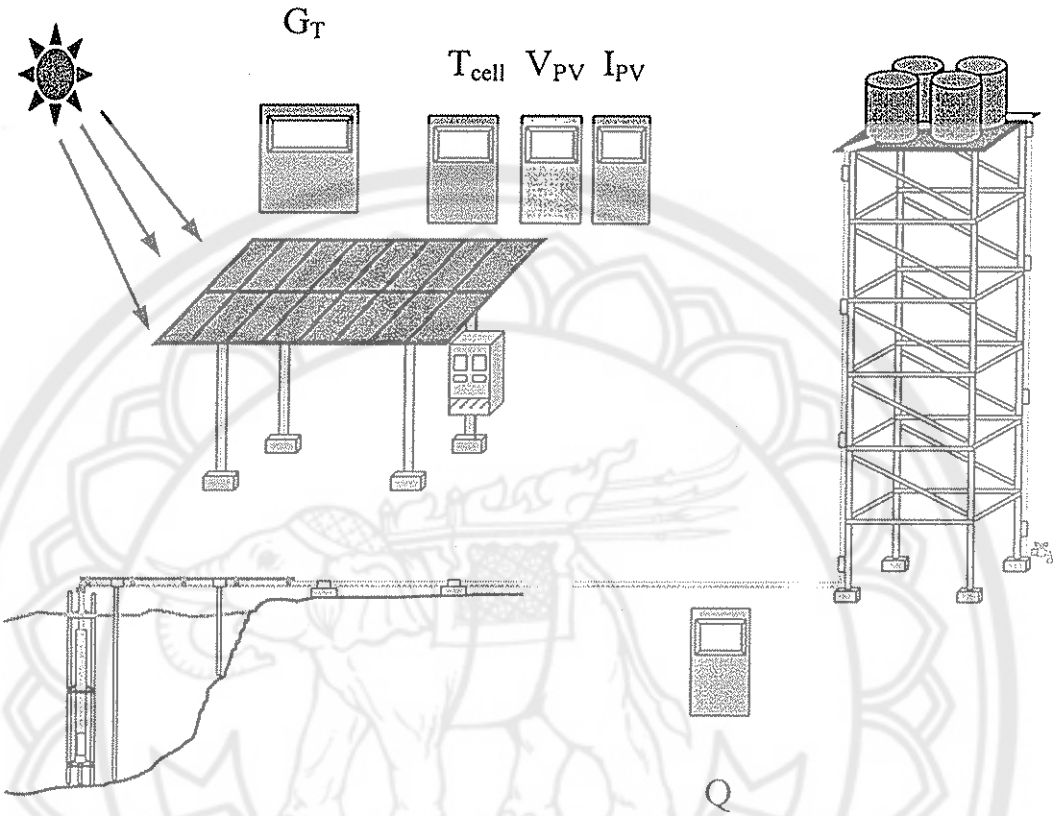

Figure 20 Diagram of the system.